

Real-life IT architecture design reports and their relation to IEEE Std 1471 stakeholders and concerns

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Abstract Architectural designs are an important means to manage the development and deployment of information technology (IT). Much debate has been going on about a proper definition of architecture in IT and about how to describe it. In 2000, the IEEE Std 1471 proposed a model of an architecture description and its context, which has been greeted with a warm welcome by many professionals in IT, but has not been applied much yet. In this paper the distance between IEEE Std 1471 and current practice is investigated. We have studied four real-life architecture descriptions from the practice of a bank and consultancy firm. These documents propose strategic decisions about application portfolios and were compiled without reference to IEEE Std 1471. Our research questions were: which parts of the document are, in the perception of the authors of those documents, relevant to which concerns of stakeholders? And, does this ‘relevancy pattern’ suggest an alternative organization in concern-related views? In other words, can the existing documents be (manually) re-engineered to IEEE Std 1471 documents? The answers to these questions enable authors to communicate more effectively to the stakeholders and can be input to future automated document generation.

We found that the ‘relevancy pattern’ is very scattered, and that an alternative organization is not evident. Most concerns are addressed by a relatively small, but each time very different, subset of the document. So re-engineering these documents to IEEE Std 1471 documents would incur an almost complete rewrite. Our research makes it very understandable that readers complain about too much information. Some stakeholders might well have difficulty finding the information of their interest.

The authors of the architecture documents found this investigation a worthwhile exercise, one which they think could be developed further into an evaluation instrument for this type of documentation. Conversely, authors of architecture documents do well to make their stakeholders and their concerns explicit up front.

Keywords IEEE Std 1471 · Architecture · Stake holder concerns · Views

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1. Introduction

Architecture is a relatively new branch within software engineering. IEEE Standard 1471 (IEEE, 2000) defines it as “Architecture is the fundamental organization of a system embodied in its components, their relationships to each other and to the environment and the principles guiding its design and evolution.” Common components of architectural descriptions are: levels or domains which divide the area of operation into manageable parts, various types of components (user interface components, security components, data management components, etc.), complex relations and behavior of all these components to deliver together the required functionality, ways to build/buy/maintain the components, planning phases (current, migration, target).

Van Vliet (2000) places the architecture design phase in the software life cycle between the requirements engineering and other design phases. During the architecture design phase, the interests and concerns of all stakeholders are taken into account by the architect to come to a well-balanced solution. The result of the architecture design phase is a series of major design decisions that put constraints on the building process as well as the product delivered. This may apply to one software product, but it may also apply to several software products. The architecture conceived plays a pivotal role during the whole life time of a system. It guides system development and evolution. In particular, the architecture description plays a key role in a reengineering project, if such documentation is available.

Readers of architecture design documents are very diverse. They may be system designers, reengineers, programmers, users, managers of user departments, managers of IT departments, auditors, and fellow architects. Architecture design documents are artifacts that serve to communicate the ideas of the designer to the stakeholders. Current practice is that designers of architectures are problem-driven. After arriving at a balanced solution that solves the problem, they write down their solution in a structured way. This can be a structuring devised for a single project or a structure following a known framework such as those of Kruchten (1995), Soni et al. (1995), or Boar (1998). Traditionally, architecture documents are organized around topics like hardware, software, organizational issues, and other broadly recognized topics. This may be very good for stakeholders whose main concerns are either hardware, or software or organizational issues, but many concerns will crosscut the traditional organization. It is here that we seek to find better ways of organizing architecture descriptions taking the concerns of stakeholders as starting points and working within the framework of IEEE Std 1471.

The organization of this paper is as follows: in Section 2 we lay out the research setting. In Section 3 we give a description of the approach we took and the activities we performed. This section is an optional intermezzo and can be skipped over. In Section 4 we present the relevancy patterns we found in the investigated documents. In Section 5 we discuss these results and draw conclusions. We end in Section 6 with a summary of the main conclusions and ideas for possible future work.

2. Research setting

In this section we lay out the research setting. We first introduce IEEE Std 1471 and develop our research questions from there. We then say a few words about the companies that were involved and the actual documents that were studied, and close with pointers to related work.

2.1. IEEE Std 1471

In this paragraph we give a short introduction of IEEE Std 1471, and we state our position towards this standard.

IEEE Standard 1471 describes a model of an architecture description (AD) and its context (IEEE, 2000). On page 1, it says: “The purpose of this recommended practice is to facilitate the expression and communication of architectures”. On page 2, it says: “Furthermore, it establishes a conceptual framework of concepts and terms of reference within which future developments in system architectural technology can be deployed. This recommended practice codifies those elements on which there is consensus; specifically, the use of multiple views, reusable specifications for models within views, and the relation of architecture to system context.”

For this study, the central ‘terms of reference’ in the IEEE 1471 conceptual model are ‘views’, ‘viewpoints’, ‘stakeholders’ and ‘concerns’. An ‘architectural description’ consists of ‘views’ that are made according to a ‘viewpoint’ (see Fig. 1). A viewpoint on the one hand prescribes the content and ‘models’ to be used, and, on the other hand, it indicates its intended ‘stakeholders’ and their ‘concerns’. Viewpoints and views have a one to one relationship. Viewpoints can be saved as library viewpoints for future projects. A stakeholder can have more than one concern. Concerns can be relevant for more than one stakeholder. In the rationale the architect explains his design choices, why he has chosen these particular viewpoints and what has not been solved. A system fulfills one or more missions and functions in a certain environment.

The standard lists a number of essential stakeholders and concerns, and gives examples of the use of architecture descriptions and of some viewpoints. The standard gives no general guidance in defining viewpoints. It only states that a viewpoint addresses a set of related concerns and that the viewpoints together should cover all the concerns of the stakeholders.

IEEE 1471 is often quoted within the architecture design community (see for instance TOGAF (http://www.opengroup.org/public/arch/p1/togaf_faq.htm), Clements et al. (2003) p. 361, de With et al. (2002)) and the proposed terms of reference are widely used and have replaced possible other terms. For this we compliment the authors of the standard.

Our position towards IEEE Std 1471 is as follows.

With respect to our interest in communication of architecture, the main contribution of IEEE 1471 is the explicit orientation on stakeholders and concerns. Following the path from his recognized concerns via the prescriptions in the viewpoint a stakeholder should be able to find the information of his interest in the views. For the architects IEEE Std 1471 is a stimulus to be very conscious of the concerns of the stakeholders and this helps him to shift away from a possibly too big emphasis on technical aspects.

Having said this, we still feel that the standard lacks vision on effective communication. For instance, being able to find all the information may in practice mean not finding the information. If a stakeholder has to refer to many different views in an architectural document and has to assemble a coherent picture on his concerns himself, this may in practice mean he will not go after this information and try to live with his best guesses. The same goes for information that is stated in terms or diagrammatic presentations that the stakeholder is not familiar with. We feel the IEEE Std 1471 should be extended with guidance to achieving qualities like “accessibility” and “understandability”.

Another thing to point at is the lack of quantitative information in the standard. This applies to sample data from real-life architecture descriptions that follow the standard, as well as to expectations about the future architectural descriptions that will be compiled following this standard. Do the authors expect on average 5 viewpoints in an AD, or 25, or 100? How many

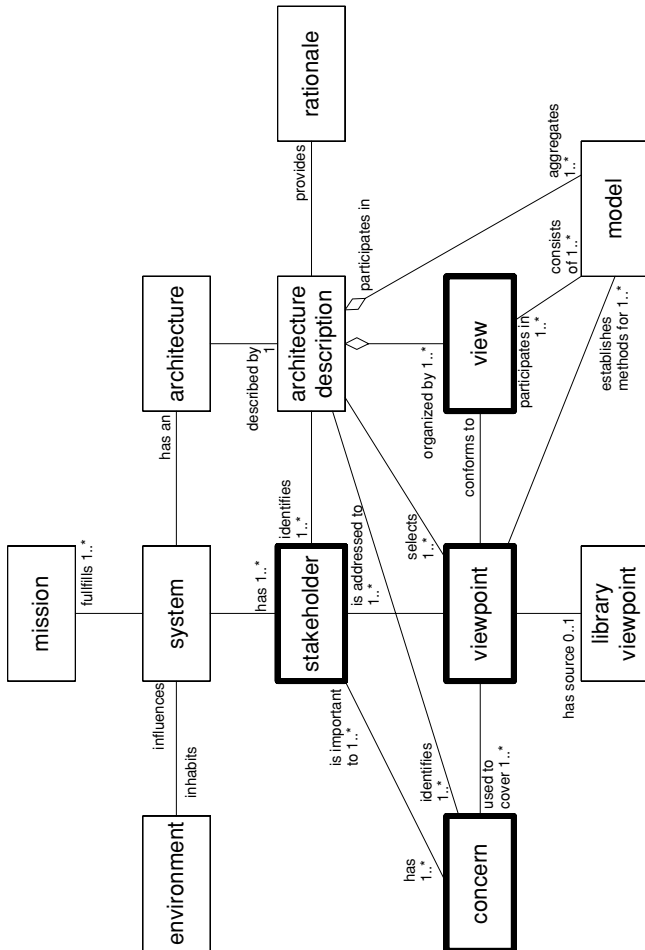


Fig. 1 The conceptual model of the IEEE 1471 standard for architectural descriptions (essential concepts for this study are indicated in bold.)

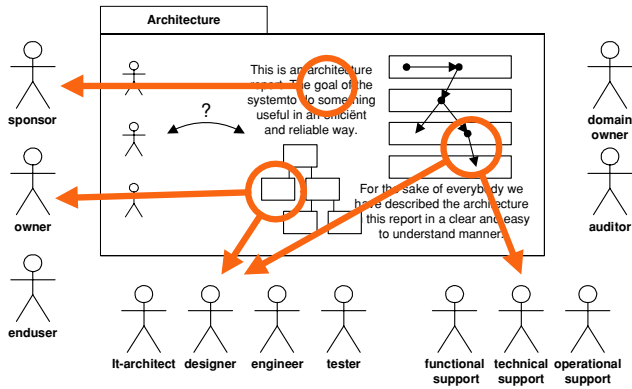


Fig. 2 One large document, from which the many stakeholders take what they need

concerns does a stakeholder have? How many viewpoints are necessary to address a concern? Not formulating at least an expectation leaves open too much room for interpretation of the standard.

2.2. Research questions

Since producing new architecture design documents following IEEE 1471, or re-producing existing ones, was beyond our possibilities, we decided to study architecture documents from the pre-IEEE 1471 era. Current practice is that architects produce one large document, from which the many stakeholders take what they need. See Fig. 2 for an informal illustration.

Our interest in communication led us to hypothesize about the possibility of chunking architecture documents such that each stakeholder is only confronted with information that addresses his concerns.

Figure 3 illustrates a situation in which a report containing all the information is split up in stakeholder oriented (concern oriented) chunks. The stakeholder is closely involved with this information, which is indicated by the small figures (one or more) standing in the report. A central, relatively small overview could still serve as a starting point for everybody.

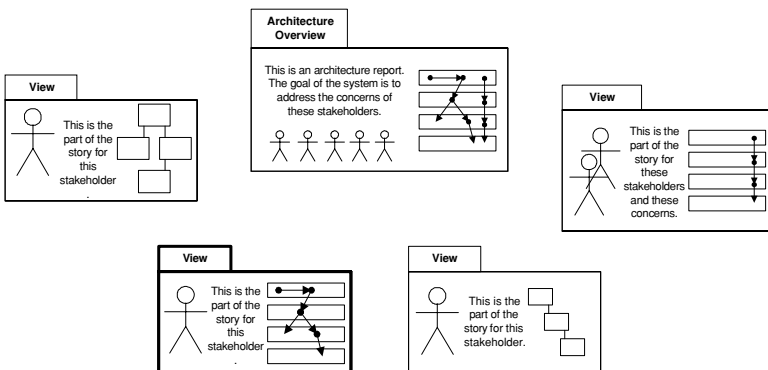
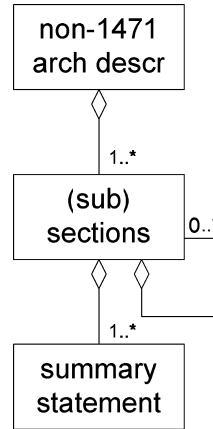


Fig. 3 Breaking up the description according to stakeholder concerns

Fig. 4 Model of a non-IEEE-1471 document



The two main questions we address in this paper are:

1. What is the relevancy of the elements of the architecture documents for the perceived stakeholders and their concerns?
2. In the perception of the authors of the architecture documents, does the relevancy pattern warrant breaking up the description in stakeholder related chunks?

Now we will represent these questions in a more formal way. In Fig. 4 we have modeled a non-1471 architecture description as a tree structure of sections and (sub)sections. For this research we have summarized each section of the investigated reports, more on this in Section 3. In Fig. 5 we relate the model of a non-1471 document (on the right) to essential concepts of the model of IEEE 1471 (on the left) by introducing two associations: one links the existing sections to re-engineered concerns of re-engineered stakeholders. The instances of this association form the answer to research question 1. Question 2 asks whether the relevancy pattern suggest new re-engineered viewpoints and views. If so, then second association links the old document organization to the new document organization in views.

2.3. The companies and the reports

The reports studied in this research activity were made available by two companies. One of them, CompA, is an international bank which attaches great importance to architecture

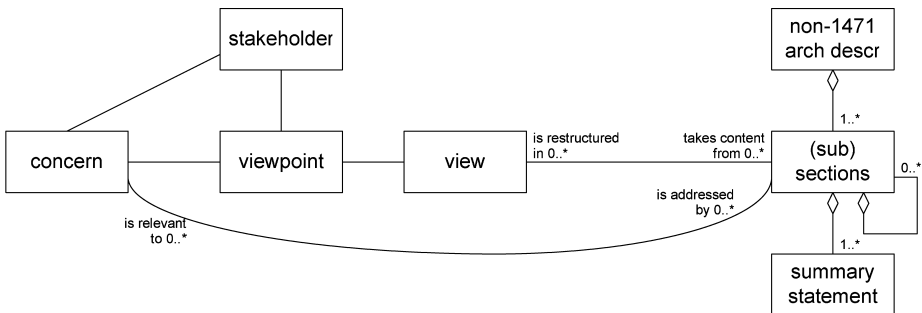


Fig. 5 Relating a non-1471 architecture description to essential concepts of IEEE Std 1471

to manage its very complex and diverse IT operations. Over 10,000 people are working in their IT departments worldwide, among them several hundred architects. The first two documents investigated were internal documents of this company. We will call them DocA1 and DocA2. Two representatives of this bank participated in our research. One was involved in the realization of DocA1. The other was the co-author of DocA2.

DocA1 is a 90-page report, describing the efforts to enable an application-to-application cooperative processing for the complete European region, the largest region of the bank. The means to achieve this are, first, the realization of a highly reliable message bus which connects all sorts of platforms and, second, a transformation of all main applications into small pieces of shareable functions called services. This report is part of a larger plan to cut the yearly costs of computer operations by 300 million Euros.

DocA2 is a 150-page report, describing the effort to greatly reduce the number of applications and to centralize the computer processing environments for one of the bank's business units, which makes up 70% of the bank's activities worldwide. It gives engineers an architectural perspective on the 200+ applications currently in use and proposes a limited set of 15 new ones. And it extensively discusses the issues involved with network access to one global processing plant, new interfaces to other business units, links to local businesses and governments in various countries, and centralized global maintenance procedures. Currently, a team of over 150 people is permanently allocated to realizing these plans.

The second company, CompB, is a professional IT-consulting firm. It has been developing a vision on managing and documenting large IT processing environments for some years. All their consultants are trained in the methodology of the company. CompB made available documents from two of their customers, CompB1 and CompB2. There were also two representatives for CompB. One was the author of DocB1 and the other was the co-author of DocB2.

CompB1 is running a chain of travel agents. CompB1 has been very successful in the market, has grown steadily, but lacked an overview of all the software applications that had been developed over the years. DocB1 is a 135-page report, giving this recovered architectural overview. It lists issues to be solved and proposed solutions, a breakdown of the main business functions, a breakdown of the data, the allocation of business functions to departments, and the level of support the current applications give. The report ends with a proposal for new or changed applications for the coming years.

CompB2 is a government agency managing the money flows involved with several regulations in national law. Over the years, these regulations have been adopted by the government and serviced by this agency in diverse ways. The agency wants to start a new, more efficient way of working, with a modern and flexible software support (envisioned to support future regulations). DocB2 is a 62-page report laying the organizational foundation for the new software support. It offers an architectural analysis of the current situation, which consists of the categories of regulations which will be supported, the commonalities and differences between current regulations, and between current work processes. It then proceeds with a proposal for a new generic work process. The report ends with a chapter containing details of the new multipurpose work processes.

2.4. Related work

As far as we know only Smolander and Päivärinta (2002) have done research regarding the use of IEEE 1471. They examined the reasons for making architecture descriptions in practice. Interviews with various stakeholders of architecture in three companies showed that beside the traditional use as a starting point for system design, architecture documents serve

to communicate, to negotiate and to capture knowledge. According to the authors, these other uses should lead to new viewpoints and new tool support. One of the recommendations of Smolander and Päivärinta is to do further research into “how communicative these descriptions appear to be in the varying contexts of their use” (p. 124). Our research is in line with their recommendation.

Hilliard (2000) tries to strengthen the formal definition of architectural views by translating concepts from the domain of designing program modules, like ‘validity checking’, ‘encapsulation’, ‘integration’, to the domain of designing architectural views. From our emphasis on stakeholder oriented communication, we appreciate ‘encapsulation’ as a mechanism to deliver the right information to the right person.

Clements et al. (2003) offer an elaborate roundup of software architecture modeling techniques that have developed over the years. They put these in a fixed framework that distinguishes module views, component-and-connector (C&C) views, and allocation views. Module views document the principal units of implementation, C&C views document the runtime units and their interaction, and allocation views document relationships between the system’s software and its environment. They add to that advanced modeling techniques, many good pieces of advice on documentation, and a list of suggested stakeholders and their information needs. In our study we offer a technique to analyse the stakeholder information in a given situation, which can give support in deciding on which parts of the fixed framework to use or adjust.

3. Wandering around, settling down, staying at IT

This section may be skipped over; without it the rest of the paper still presents a complete report of our results. At this point we insert an intermezzo—“for whom it may concern”. In this intermezzo, we describe the search to find a workable research method. We not only describe the successful activities, but also the wandering around to find them. It took us some time to find a proper and balanced way of dealing with the questions raised. Actually it was a search process till the very end. More than once, our ability to adjust our thinking and change directions was stretched to the limit. We think it is also interesting to see what did **not** work. Also, this section may help to properly assess the value of our findings and understand the limits of their applicability, and it illustrates the collaboration between researchers and practitioners in defining the research question, that is an integral part of the *action research* approach we follow (Avison et al., 1999; Baskerville, 1999; Susman and Evered, 1978). In this approach researchers and practitioners work together to find improvements in a real life situation, which is too complex to transfer to a clinical research environment.

The activities were performed over a period of nine months, with a capacity of two-person days per week, overhead included.

Many things go through one’s mind when seeking a way to do new things. The steps we took can be roughly characterized by these one-liners:

- Agreeing on a *research question* with all the participants
- Deciding on the *data* to capture and trying various ways to record them
- Unsuccessfully trying to let the participants do it *themselves*
- Doing it *ourselves* and learning a lot
- *Finishing* it ourselves, but not achieving the goal
- *Successfully* letting the participants do it themselves.

We had been thinking a lot about formulating a *research question* in the realm of architecture that would be potentially beneficial to the participating companies, but also recognizable to the research community. The applicability of the IEEE 1471 standard had both qualifications. The companies knew of the standard, had a positive impression of it, but had not yet worked with it in practice. So we prepared a proposal based on IEEE Std 1471, and suggested right away to go after the most challenging stakeholder as far as communication of architecture is concerned, the end-user. Our assumption here is that architectural decisions can have implications for end-users and should be discussed with them. We studied literature from requirements engineering, Kotonya and Sommerville (1998), and user interface design, van Welie (2001), to find the essential attributes for stakeholders and concerns. The participants later on choose to use free format descriptions of stakeholders and concerns rather than a fixed format. The participants found we had taken big steps in deciding on a subject and needed more time to decide on the research question to address. We designed an evaluation form for them to do a quick sketch of stakeholders and concerns addressed in a document.

In the next round they were convinced this was a good idea, but asked us not to limit the investigation to just end-users. A list of perceived common stakeholders was compiled by all architects involved in this study, which we briefly mention here to give you some idea: sponsor/investor, owner, end-user, domain owner, architect, designer, engineer, tester, functional supporter, technical supporter, operational supporter. When the documents were chosen this list proved not useful. The stakeholders were not so common after all. In Section 2.2 we mentioned already the research questions eventually agreed upon.

Deciding on the *data* to capture brought to light that the IEEE 1471 model, though at first sight easy to follow, is in fact quite complex. We started on building a prototype application for data capturing in MS Access, with which the participants could identify and categorize elements of an architectural description, define IEEE 1471 stakeholders and concerns and specify the relevancy of the elements for them. We very soon were spending a lot of time precisely positioning data input fields and text labels, and other complex programming issues doomed (such as capturing n:m relations). Also, the participants would probably not be very enthusiastic about spending hours filling in very detailed data-entry screens. With all the uncertainties about the right way to go, that seemed not to be a good investment of our time.

Since one of us was familiar with MS Visio (from drawing architecture diagrams as an IT-consultant) we tried another route, and designed an interactive, graphical representation with four columns: stakeholder, concern, architecture statement, component, see Fig. 6 for an example representation hereof. The first two columns were intended to capture the essential stakeholders and their (shared) concerns. The last two columns were intended to express the essential content of an architecture. Our idea was that we could ask the architects to summarize their own design reports in columns three and four. It was fun to make and had appeal. We had a few tryouts on our own which went rather well, but left us with some doubt about the precise semantics of the fourth column, is the concept ‘component’ addressing the heart of an architecture design?

We then tried to let the participants express the relation of document elements to stakeholders and concerns *themselves* by means of this graphical representation. We arranged a collaborative session with representatives of one company in which they could ‘think aloud’ and we would edit the diagram. It went not very well. It was difficult for them to formulate the main concerns by heart, and at the same time formulate the architecture statements to address them. They found it difficult to express the essence of the architectures by means of items in the 3rd and 4th columns of our scheme.

So the only way forward seemed to be to first do an analysis all by ourselves. In the next session with the representatives of the other company, we asked them to give us a

SAM Architecture

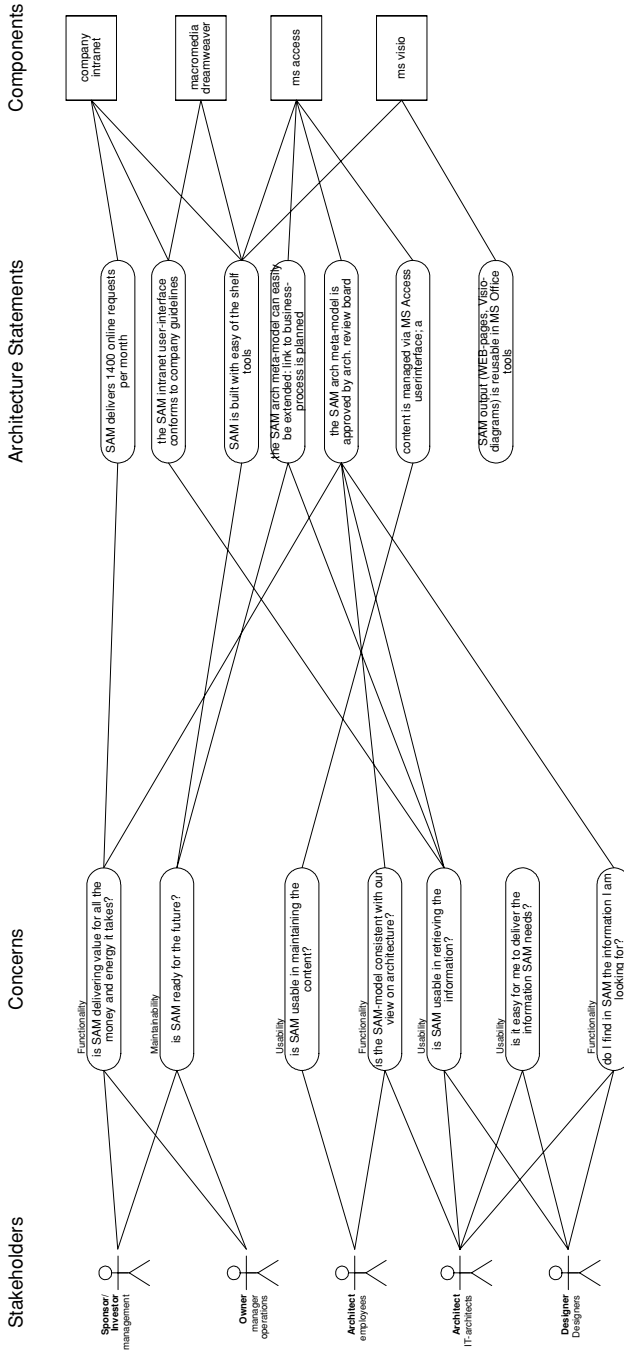


Fig. 6 Experimental graphical presentation of stakeholder concerns related to architectural statements

head start for our own analysis by objectively naming stakeholders and concerns per report (columns 1 and 2). This went rather well, but these head start data were eventually not used.

We then started to do an analysis of the document *ourselves* (which in the end proved to be very instructional for us). Again, how to go about it? After a lot of thought we started by simply making a résumé of one of the documents. This was straightforward. From our own experience in the field, the content of the document was very recognizable. After finishing the first content summary, we transformed it into a table having three columns: type of content, stakeholders and concerns and general remarks. The column ‘type of content’ was a vain attempt to arrive at a categorization of architectural statements, that could be linked to, for instance, types of graphical presentations (a leftover from our research into guidelines for readable diagrams in the year before). In the column ‘stakeholders and concerns’ our best guess was noted about what party in the company would be most interested in the content and why. Sometimes the report itself gave indications to this end. In ‘general remarks’ we put our questions concerning the content, our observations on the use of diagrams and our ideas about what makes an architecture design report readable. Summarizing all the four documents was a lot of work, tedious work.

At the next meeting with all the representatives we had analyzed in this way three reports fully, and one report half. At almost the last minute before the meeting we had prepared concept maps of each of them showing the main architectural concepts. Figure 7 is an example that show the concepts that were treated in one of the design reports. It is a derivative of a more general conceptual model used by CompB and is similar in function to architecture meta-models as proposed by, for instance, Hofmeister et al. (1999). The representatives did not have many comments on the analyses, but were pleasantly surprised with the ideas for making a report more readable and the concept maps. We were kindly asked to fulfill a consultant role in a project to devise seven new target architectures, and, to finish the analyses of the documents and draw our conclusions.

The feeling grew we were on the right track and valuable insight was coming out of this. We *finished* our part of the tables. At that moment, in our view, it remained unsatisfactory, mainly on two points. It proved very difficult to discern from the text of a report the main stakeholders and their interests. From our own experience, it was not difficult to discern content that would be of value for persons in the roles of manager, designer, programmer, etc. But were all these stakeholders present in the various companies? And what were exactly their responsibilities? So we had our best guesses, but no facts. And there was another thing. In our mind the question of what data to record had not been settled. Should we simply, superficially, record that some document element was relevant for a certain concern, as a mere yes or no? Or should we dig a bit deeper and try to figure out what this piece of information means to the concern? And what aspect of the concern does the information touch? We decided to keep it simple and only record a yes or no as the whole operation was already complicated enough.

The last step was to go back to the participants. This *successful* step is described in the next section, an introduction to the results of the analysis. At this point we want to say that this final step was easy going. The participants really got involved, and even seemed to like the exercise. We had the feeling that it gave them a means to express something they maybe tacitly knew, but were not able to express so clearly before. The only thing not so pleasant for them was that in their own opinion evidently not all the stakeholders were interested in the whole report. Actually, almost no one was, but that already brings us to the discussion of the results.

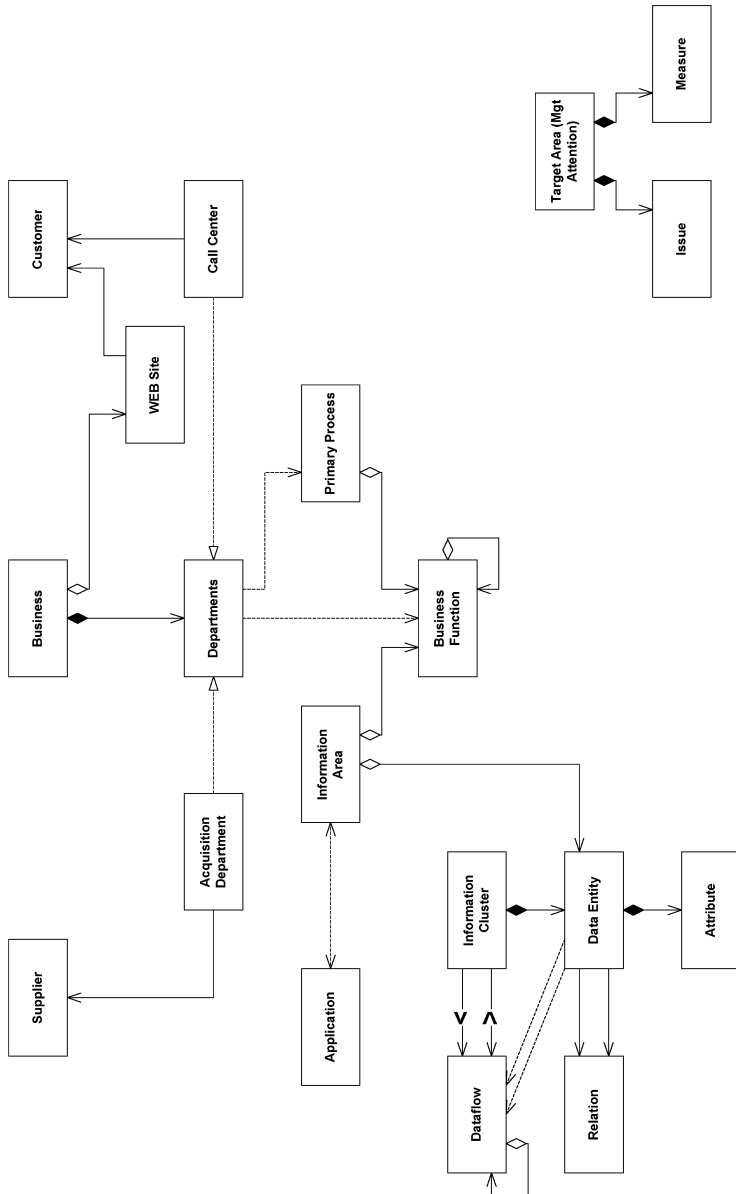


Fig. 7 Map of the main concepts of an architectural design report in this study

4. The relation to stakeholders and concerns

This section shows, for the four architecture reports mentioned in Section 2.3, the relationships between the various parts of the content, and the perceived stakeholders and their concerns. These tables represent the opinion of the persons who are co-authors of these reports or who are closely involved in carrying out the design decisions of the reports.

The tables were compiled as follows: The participants were provided with tables containing summaries we had made of the reports. In separate collaborative sessions we asked the participants to mention the main stakeholders whose concerns had determined the content of the architecture. For each stakeholder we asked the participants to list the main concerns that would drive the interest in the report of that specific stakeholder. To keep things manageable, we asked them to try to identify not more than about eight concerns. We left it to the participants to decide on which level of content they wished to put checkmarks. The preference seemed to be for the chapter level and, in some cases, on the paragraph level. We had three separate sessions (DocA1 and DocA2 in one session, and DocB1 and DocB2 in separate sessions). All participants, except one with whom we lost contact because of a job change to another company, reviewed the outcome some weeks later and made minor changes.

The results are given in Table 1, 2, 3 and 4. See Section 2.3 for short descriptions of these reports. The second column of Table 3 represents concerns of the author himself.

We did not ask for details of the stakeholder descriptions and their roles. That information is not relevant for the pattern of the information retrieved from the documents. When specifically asked, all participants said that the information in the report was sufficient for the stakeholders to see how his concerns were addressed. The participants found producing the tables a worthwhile exercise, which can be easily repeated for other architecture documents to evaluate the document design or the final product. Almost all of the participants spontaneously remarked that if they had to produce documents per stakeholder with overlapping content, they would need an automated tool.

5. Observations

With respect to the tables, we observe the following:

- The pattern of the checkmarks is rather scattered, especially for DocA2 and DocB2. This seems to indicate that the interest in the report varies considerably. (We did some rough statistical measurements on the ‘similarity’ between columns and the result confirmed our observation.)
- Almost none of the stakeholders is interested in the full report. Some are only interested in very little of its content. This is contrary to the tacit assumption of many architects to be writing a report that is of general interest. Our conjecture is that if this study would be repeated at a more fine grained level, the ‘percentage of interest’ would even be lower.
- The very partial interest stakeholders have in the contents of the reports makes one wonder how easily they can find the information they need. In our opinion, this issue deserves further investigation.
- There is no correspondence between stakeholder interest and chapter divisions. This strengthens the idea that what is a logical structure for an architect, is not necessarily a logical structure for a stakeholder.
- The intuitive approach taken to establish these tables makes us hesitant about doing extensive statistical analysis. We left the totals in the tables as a service to the readers.

Table 1 Relationship of chapters in DocAI to the concerns of five stakeholders

Report chapters	Stakeholders and concerns									
	Business user representative		CIO		Developer		IT-Architect		Project-leader	
	do the applications fill my business needs?	what are the consequences of this architecture?	what projects are needed?	how can I make the IT cheaper?	how can I make the alternatives available?	how does my project fit in the architecture?	how to advise for project approval?	how to help projects?	which components can be reused?	Total (max 9)
2 Overview		X		X	X	X	X	X	X	7
3 Overall Policies	X	X		X	X	X	X	X	X	7
4 Concepts and Blueprint		X		X	X	X	X	X	X	6
5 Defined Unified Services					X	X	X	X	X	4
6 Technical Interface Model					X	X	X	X	X	2
7 Usage Patterns					X	X	X	X	X	2
8 Non-functional Attributes					X	X	X	X	X	2
9 Security Model					X	X	X	X	X	2
10 API and Adapters Platform Strategy and Policies					X	X	X	X	X	2
11 Operational Management					X	X	X	X	X	2
12 Development Toolkits and Standards					X	X	X	X	X	2
13 Migration Considerations	X				X	X	X	X	X	4
Total (max 12)	1	4	0	3	4	12	4	12	2	

A checkmark behind a chapter in one of the columns means that the stakeholder needs the information from that chapter to know how his/her concern is addressed.

Table 2 Relationship of paragraphs in DocA2 to the concerns of five stakeholders

Report paragraphs	Business user representative					Stakeholders and concerns				
	do the applications fill my business needs?		what are the consequences of this architecture?		CIO	Developer	IT-Architect	Project-leader	Total (max 9)	
	what are the consequences of this architecture?	what projects are I needed?	how can I make the alternatives are available?	how does my project fit in the architecture?	how to advise for project approval?	how to help for projects?	which components can be reused?			
Introduction	X	X	X	X	X	X	X	X	9	
2.1 Issues with current IT environment	X		X	X	X				2	
2.2 Current Application Inventory	X		X	X	X				3	
3.1 IT Architecture Objectives		X	X	X	X				3	
3.2 IT Design principles		X	X	X	X	X	X	X	4	
3.3 IFSA Compliance		X		X	X	X	X	X	6	
4.1 Functional Breakdown	X								2	
4.2 Data Model Overview	X								2	
4.3 Target Application Portfolio	X		X	X	X				5	
4.4 Major System Interfaces			X	X	X	X	X	X	5	
4.5 Strategic versus Tactical Solutions	X		X	X	X	X	X	X	7	
4.6 Special Facilities	X		X		X	X	X	X	5	
5.1 Technical Standards				X	X	X	X	X	6	
5.2 Technical Architecture Requirements				X	X	X	X	X	4	
5.3 Technical Infrastructure		X	X	X	X	X	X	X	5	
5.4 Technical Architecture of core banking application	X	X	X	X	X	X	X	X	6	
5.4.1 Physical application and database					X				1	
5.4.2 Client server model: this section					X				1	
5.5 Technical Architecture of Other Applications	X	X	X	X	X	X	X	X	6	

(Continued to next page)

Table 2 Relationship of paragraphs in DocA2 to the concerns of five stakeholders

Report paragraphs	Stakeholders and Concerns					Total (max 9)		
	Business User Representative	CIO	Developer	IT-Architect	Project-leader			
	do the applications fill my business needs	what are the consequences of this architecture?	what projects are needed?	how can I make the IT cheaper?	what alternatives are available?		how does my project fit in the architecture?	how to advise for project approval?
5.6 Interfacing architecture	X	X	X	X	X	6		
5.7 Print/output architecture	X	X	X	X	X	6		
6.1 IT Operations Processes	X	X	X	X	X	5		
6.2 Operations Management Software	X	X	X	X	X	5		
6.3 Security Architecture	X	X	X	X	X	5		
7.1 Environments		X	X	X	X	3		
7.2 Development Tools and Standards		X	X	X	X	3		
7.3 Change control						0		
8 Relation to other Service Centers	X	X			X	3		
Total (max 28)	13	16	5	19	15	13	15	13

Table 3 Relationship of paragraphs in DocB2 to the concerns of ten stakeholders

	Stakeholders and Concerns										
	Commissi oner	Process architect	Process designer	Information Manager	Business do- main architect	General Project Manager	Application Architect	IT domain architect	Functional Designers	IT-project leader	
Report chapters and paragraphs	how can I efficiently administer new regulations? like?	what does the solution look like?	can I produce a clear process design?	how do I the organisation for using this solution?	what is the effect of this process architecture on my business domain?	does this fulfill the commission? scope)?	with which application (current, new) will we realise a clear functional statement of work?	what is the impact on the IT -support in my IT -domain?	can I produce a clear functional design?	what do I need for my statement of work?	Total (max 11)
1 Introduction	X	0		X	X	X	X	X	X	X	10
2.2 Target vision	X	0		X	X		X	X			4
2.3 Current problems	X	0		X	X		X	X			4
2.4 Design goals	0	0		X	X		X	X			4
3.2 Considered regulations	X	0		X	X				X		4
3.3.1 Scope in business proces model	0	0		X	X	X	X	X	X		5
3.3.2 Relations to other projects	0	0		X	X	X	X	X	X		8
3.4.1 Products and services	0	0	X	X	X				X	X	5
3.4.2 Customer-to-customer processes	0	0	X	X	X		X	X	X		7
3.5 Demarcation relevant business functions	0	0		X	X		X	X	X		4

(Continued to next page)

Table 3 Relationship of paragraphs in DocB2 to the concerns of ten stakeholders

	Stakeholders and Concerns					Total (max 11)
	Commissi oner	Process architect	Process designer	Business do- main architect	ApplicationIT domain Architect	
Report chapters and paragraphs		how can I efficiently administer new regulations? like?	what does the look like?	what is the effect of this process on my business domain?	with which application the impact will on the IT produce a clear my functional statements design? of work?	
4.2 Current organisation	0	how do I prepare the for	how to manage (pitfalls, risks, resources, this commission? scope)?	how to manage (pitfalls, risks, resources, this commission? scope)?	how to manage (pitfalls, risks, resources, this commission? scope)?	4
4.3 Commonalities and differences in current workprocesses	0	can I produce a clear process design?	does this fulfill the commission? scope)?	does this fulfill the commission? scope)?	does this fulfill the commission? scope)?	5
4.4 Commonalities and differences in current use of information	0					4
4.5 Current IT support	0					3
4.6 Conclusions current situation	X					8
5.2 Target organisation	0					5
5.3 Target use of information	0					6
5.4 Target IT support	0					5
5.5 Conclusions target situation	X					9

(Continued to next page.)

Table 3 Relationship of paragraphs in DocB2 to the concerns of ten stakeholders

	Stakeholders and Concerns						Total (max 11)			
	Commissi oner	Process architect	Process designer	Information Manager	Business do- main architect	General Project Manager		Application Architect	IT domain architect	Functional Designers
how can I efficiently administer new regulations?	what does the look like?	can I produce a clear design?	how do I prepare the organisation for using this solution?	what is the effect of this process architecture on my business domain?	how to manage (pitfalls, risks, resources, commission?) scope)?	with which application (current, new) will we realise this solution?	what is the impact on the IT -support in my IT -domain?	can I produce a clear functional design?	what do I need for my statement of work?	
6.2 Overview customer-to -customer processes	0	X	X	X		X	X	X		7
6.3 Process Send Form	0		X					X		3
6.4 Process maintain customer info	0	X						X		3
6.5 Process process forms	0		X					X		3
6.6 Process compile receipt	0		X					X		3
6.7 Process process claims	0		X					X		3
6.8 Process info request	0		X					X		3
Total (max 26)	6	26	8	11	17	5	12	18	17	4

Table 4 Relationship of chapters in DocBI to the concerns of five stakeholders

Report chapters	Stakeholders and Concerns					Total (max 7)
	Information manager	CEO	User Management	Functional Coordinator	Developer	
1 What is architecture?			do we have the proper IT support for our workprocesses (workable and fitting)?	how can I estimate the impact of changes (time & money on a functional level)?	how can I manage the developers with respect to application functionality?	1
2 Target Areas	X	X	X	X	X	3
3 Business functions 'from acquisition to sales'	X		X	X	X	5
4 Conceptual data model 'from acquisition to sales'	X		X	X	X	4
5 Organization model and information areas	X		X	X	X	4
6 Application architecture (current and future)	X	X	X	X	X	5
Total (max 6)	5	2	5	3	2	4

- The architects liked the insight into the interest of stakeholders found in these tables. One architect came with the suggestion that this kind of table could be used as a ‘reading guide’ in the introduction of a report. Another architect remarked that an explicit attention to stakeholder concerns would have led him to produce less documentation.
- When there is a clear dividing line for splitting a large document, it can probably be noticed early in this way.

With respect to the main research questions (What is the relevancy of the elements of the architecture document for the perceived stakeholders and their concerns and does the relevancy pattern warrant breaking up the description in stakeholder related chunks?), the following observations can be made:

- We illustrate the relevancy patterns in the tables we compiled in a simplified way. This simplified way was necessary to prevent us from losing ourselves in complexity. It also seemed to match well the intuitive, broad-brush approach of the architects.
- The tables show that stakeholders are mostly interested in only part of the document, often less than half of it.
- DocA1 seems to have a clear dividing line for a breakup into one part of general interest and another part of interest to the developers. Such a clear division is not obvious in the other documents.
- For practical reasons our investigation was limited to the surface level of the current compartmentalization of the documents. The big differences in the meaning of the concerns of the various stakeholders make us believe that even stakeholders who refer to the same part of a document, actually look at different things.
- In DocB1, the chapters (3, 4 and 5), which describe the analysis of the current situation, seem to play a different role than the more decision-oriented chapters (2 and 6). The analysis chapters will mainly be used for subsequent application design and project control. The decision chapters are the basis for initiating the right projects.
- Distributing many copies of slightly different variants of a report would probably create a lot of confusion. There is also some organizational psychology involved: “Maybe I don’t need all the information, but at least I have the same information my colleagues have”.

With respect to IEEE 1471 we observe the following:

- IEEE 1471 leaves open the question of how to arrive at proper viewpoints. This openness is intentional, since architectural methods and organizations differ, and have their own rules for doing so. In our case, each column of the tables in Section 4 represents a concern. Taking the columns of the tables in Section 4 as the content of as many viewpoints will probably lead to documentation that is too fragmented and difficult to maintain.
- The chapters in the tables of content of the four reports show a clear grouping, mostly around some type of architectural concept, like ‘business functions’ or ‘applications’. One could call this ‘natural’ organization “views” and declare each chapter to be a view. Compared to IEEE 1471 they still lack an explicit relation to stakeholders and concerns, but they do support the claim of IEEE 1471 that architectural documents are organized in views.
- In this small sample set of documents stakeholders and concerns are very different from one company to the next. This supports the choice of the IEEE 1471 design team to stick to a very open conceptual model.

Some general observations:

- This investigation very much underlines the value of being conscious of the relevancy of the architecture document for the different stakeholders and their concerns.

- Along the way we gained experience with representing the essence of an architecture report by means of concept maps, see Fig. 7. We expect the use of concept maps to give visual support to the design of IEEE 1471 viewpoints by giving support in reasoning about which concepts are useful for addressing which concerns. Hilliard did something similar using UML (Hilliard, 1999).
- The variety of stakeholders, concerns, and content of the architecture document underlines the complexity of the practical situations in which architects work and shows that the ‘art of architecting’ is very situational.
- A possible future automated tool to generate stakeholder oriented documents from a central information base must be very flexible and adjustable to the needs of a particular project as they arise.

6. Conclusion and future work

Our main conclusions are:

- Many concerns are addressed by a surprisingly small part of the document. Concerns that refer to less than 25% of the document are no exception, see the tables of chapter 4.
- The pattern of stakeholder interest in the content of the documents is very scattered, which makes it difficult to devise a uniform scheme for breaking up the documents into smaller parts. Except for one document there is no clear dividing line for breaking up the documents.
- Specific stakeholders might well have difficulty finding the information of their interest (this is a documentation concern that definitely needs to be addressed).
- The authors of the architecture documents found this investigation a worthwhile exercise, an exercise which they think could be developed further into an evaluation instrument for this type of documentation.
- Conversely, authors of architecture documents do well to make their stakeholders and their concerns explicit up front, and organize their documents accordingly, as opposed to merely following the solution structure.

We recommend experimenting with other ways of compiling architectural documents. For instance, at some point during the writing process, it might help to visualize its contents in a table whose rows represent the problem-solution ordering of the main architectural concepts and whose columns represent the stakeholders and their concerns. The entries of the table could then be filled with descriptive text which maps an architectural issue onto a concern of a stakeholder.

IEEE 1471 uses architectural views as the primary organizing principle for architecture documents. Furthermore, all relevant stakeholders and their concerns should be addressed somewhere, so this functions as a *completeness* principle. Our concern is the communication between architects and stakeholders. So we took the stakeholders and their concerns as a point of departure, and investigated how elements from several real-life architecture documents related to them.

Stakeholders and their concerns seem to be situational, and they have to be determined time and again. If these stakeholders and their concerns are not explicitly identified up front, chances are that the document is difficult to comprehend, for some or all of the stakeholders. We recommend using techniques as described in this paper, to do an early stakeholder and concern identification on proposed architecture descriptions. We are currently involved in workshops with IT architects to use this instrument in writing architecture documents.

Seen from an action research perspective, this research activity represents the diagnosis phase, which has given us important clues as to why stakeholders complain about architecture documents, and has given us ideas for improvement.

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